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Vol. IV MAY, 1917 No. 5

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PROCEEDINGS

NOTICE OF REGULAR MEETING.

A REGULAR meeting of the Boston Society of Civil Engineers will be held on

WEDNESDAY, MAY 16, 1917,

at 7.45 o'clock P.M., in CHIPMAN HALL, TREMONT TEMPLE, BOSTON.

Lieut. George D. Murray, United States Navy, will address the Society on "The Problems of Aviation as Applied to the Navy."

A representative of The Burgess Company, of Marblehead, will also be present and will speak on "Aviation," illustrating his remarks with lantern slides.

S. E. TINKHAM, *Secretary.*

PAPERS IN THIS NUMBER.

Address at the Annual Meeting, March 21, 1917. Richard A. Hale.

"China Mills Dam and Sluiceway of Suncook Mills." Arthur T. Safford.

"When to Dimension in Feet and Inches and When in Inches Alone." Sturgis H. Thorndike.

"Needs of the Engineers in War."

CURRENT DISCUSSIONS.

Paper.	Author.	Published.	Discussion Closes.
"History and Present Status of the Concrete Pile Industry."	Charles R. Gow.	April.	Aug. 10.

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Contributors are hereby notified that proof will not be submitted to them for examination unless requested before the 10th of the month preceding the month of publication.

MINUTES OF MEETINGS.

BOSTON, April 11, 1917. — A special meeting of the Boston Society of Civil Engineers was held this evening in Lorimer Hall, Tremont Temple, Boston, and was called to order by the President, George C. Whipple, at 7.50 o'clock. There were about 250 members and guests, including representatives from the Boston Section of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the Boston Society of Architects and the Boston Architectural Club.

The President welcomed most cordially the members of other organizations which had been invited to join in this "Military Night" of the Society, and delivered a short address on what the Society should do in war time, and suggested certain work which the Society should take up. A communication was read by the Secretary in relation to the formation of a regiment of engineers and practical construction men in connection with the division of troops Colonel Roosevelt is planning to take to France if permission of the War Department is obtained, and enrollment blanks were presented.

The President then introduced the first speaker of the evening, Lieut.-Col. W. P. Chamberlain, Medical Corps, U. S. A., who spoke on "Military Sanitation," illustrating his remarks with lantern slides.

Capt. F. B. Downing, Corps of Engineers, U. S. A., followed with an interesting talk on the "Organization and Duties of Engineer Troops," which was also illustrated with many slides, showing the work of the engineer, not only in our Civil War but in the present European War.

The last speaker was Capt. John F. Osborn, a member of the Society, who spoke particularly on the engineering instruction now being given in the First Corps of Cadets, Massachusetts National Guard, and on the movement to change the Corps from infantry to engineers. His talk was illustrated with lantern slides.

Mr. C. W. Sherman offered the following resolutions which were adopted by a unanimous vote:

Whereas, the First Corps of Cadets, Massachusetts National Guard, has, at the request of the War Department, undertaken to form a regiment of engineers to complete the organization of the New England division of the National Guard; and

Whereas, it is the sense of this meeting that the city of Boston is the only practicable location for the headquarters of such a regiment, because of the fact that it is the engineering center of New England, the location of the largest engineering societies in New England, and in close proximity to some of the leading engineering schools in the country; and

Whereas, it is the sense of this meeting that the Boston Society of Civil Engineers would be better able to coöperate with the First Corps of Cadets in the organization and maintenance of such a regiment than with any other existing military organization;

Now, therefore, be it resolved, that it is the sense of this meeting that the Boston Society of Civil Engineers should officially endorse the organization of such a regiment and coöperate in every way with the First Corps of Cadets in the organization and maintenance thereof; and be it further

Resolved, that the Board of Government be requested to appoint a committee which shall immediately take steps for the coöperation on the part of this Society in every possible way in the organization of such a regiment.

Past President Gow offered the following, which was adopted by a unanimous vote:

Voted: That the President of the Society be authorized to appoint a committee to study the necessary steps for the closer coöperation of the sanitary engineers with the medical division of our army.

After passing a vote of thanks to Colonel Chamberlain and Captain Downing, for their kindness in coming before the Society and giving the interesting and instructive addresses to which we had listened, the Society adjourned.

S. E. TINKHAM, *Secretary.*

BOSTON, April 18, 1917. — A regular meeting of the Society was held this evening at Chipman Hall, Tremont Temple, and was called to order by the President, George C. Whipple, at 8 o'clock. There were 90 members and visitors present.

The reading of the record of the annual meeting was dispensed with, and it was approved as printed in the April JOURNAL.

The Secretary announced the election, by the Board of Government, of the following members: Stuart E. Coburn, Grover Cleveland Coffin and Frank Sidney Hanf.

The Secretary reported, for the Board of Government, that, under authority of a vote passed at the annual meeting, the following committees had been appointed:

On the Library — S. E. Tinkham, H. F. Bryant and F. I. Winslow.

On Publication — C. W. Sherman, L. E. Moore and A. W. Dean.

On Papers and Program — G. C. Whipple, S. E. Thompson, C. T. Fernald, A. W. French, H. J. Hughes, E. H. Rockwell and S. E. Tinkham.

On Membership — R. A. Hale, E. R. Kimball and P. C. Nash.

On Run-Off — A. T. Safford, H. S. Boardman, X. H. Goodnough, R. A. Hale, H. A. Moody, C. H. Pierce, G. E. Russell, C. W. Sherman, W. F. Uhl and D. M. Wood.

On Revision of Civil Service Rules — F. H. Fay, C. R. Gow, R. M. Whittet, J. E. Carty and E. H. Rogers.

The President announced the death of Past President Joseph P. Davis, which occurred on March 31, 1917, and later in the meeting Vice-President Sherman announced the death of Otis F. Clapp, a member of the Society, which occurred on March 3, 1917.

The President was requested, by vote, to appoint committees to prepare memoirs. He has appointed the following committees:

On memoir of Joseph P. Davis, Messrs. F. P. Stearns and E. W. Howe.

On memoir of Otis F. Clapp, Messrs. W. D. Bullock and I. S. Wood.

The President then introduced Past President Charles R. Gow, who, with the aid of numerous lantern slides, gave a most interesting description of the various forms of concrete piles, substantially as covered by his paper printed in the April, 1917, number of the JOURNAL of the Society.

With Vice-President Charles W. Sherman in the chair, a discussion followed in which the following took part: Mr. Thomas W. Clarke, of the New England Foundation Company; Mr. L. Hart, of the Raymond Concrete Pile Company; Mr. John T. Scully and Mr. H. E. Sawtell.

Adjourned.

S. E. TINKHAM, *Secretary.*

APPLICATIONS FOR MEMBERSHIP.

[May 4, 1917.]

THE By-Laws provide that the Board of Government shall consider applications for membership with reference to the eligibility of each candidate for admission and shall determine the proper grade of membership to which he is entitled.

The Board must depend largely upon the members of the Society for the information which will enable it to arrive at a just conclusion. Every member is therefore urged to communicate promptly any facts in relation to the personal character or professional reputation and experience of the candidates which will assist the Board in its consideration. Communications relating to applicants are considered by the Board as strictly confidential.

The fact that applicants give the names of certain members as reference does not necessarily mean that such members endorse the candidate.

The Board of Government will not consider applications until the expiration of twenty (20) days from the date given.

Long, William James, Woonsocket, R. I. (Age 24, b. Woonsocket, R. I.) Educated in public schools of Woonsocket and at Rhode Island School of Design, Providence; is now taking course in reinforced concrete engineering. Spent three summers as time clerk and waterboy for Woonsocket Water Dept.; for past six years has been with Eastern Construction Co., engineers and general contractors, Woonsocket; has served as time clerk, cost clerk, subforeman, foreman, and draftsman, and is now estimator for that company. Refers to F. A. Caldwell, D. R. Howard, F. H. Mills, C. F. Parker and Arnold Seagrave.

Palmer, Walter Thomas, Faneuil, Mass. (Age 27, b. Caywood, Ohio.) From 1910 to 1911, student at Ohio State University; in 1911 and from 1915 to date, evening student, Carnegie Inst. of Technology. From 1907 to 1910, rodman with Rock Island Ry.; from 1911 to 1913, resident engineer with Lake Erie & Northern Ry.; from 1913 to 1915, engineer on erection of structural steel and reinforced concrete with Dominion Bridge Co. and Cramp & Co. respectively; from 1915 to 1917, with Witherow Steel Co. on design of reinforced concrete and sale of reinforcing steel; is now New England manager for this company. Refers to W. M. Bailey and B. S. Brown.

Probst, Arthur Frederick, Roslindale, Mass. (Age 38, b. Brooklyn, N. Y.) From February, 1896, to March, 1900, with Keuffel & Esser Co., New York, N. Y.; from March, 1900, to September, 1902, with Eugene Dietzgen Co., New York; employed temporarily by John Matthews, Inc., manufacturers of carbonated waters; from February, 1904, to August, 1906, with Kolesch & Co., manufacturers of surveying instruments and importers of drawing materials; September 1, 1906, became associated with G. G. Ledder under firm name of Ledder & Probst; since December 1, 1909, has conducted the business alone, and is now president and treasurer of Ledder & Probst, Inc. Refers to H. S. Adams, H. F. Bryant, J. H. Duffy, R. K. Hale, B. L. Makepeace, E. E. Pettee, R. H. Whiting, F. J. Wood and H. B. Wood.

St. Amand, Louis J., Roxbury, Mass. (Age 27, b. Boston, Mass.) Graduate of Boston English High School, 1909; later took courses in structural designing, reinforced concrete and hydraulics at Franklin Union. In 1910 and 1911, transitman with Fuller Whitney Surveys Corp'n; in 1911–12, assistant engineer with Silverman Engrg. Co., and with T. A. Appleton; in 1912, assistant in office of Whitman & Howard; in 1913 and 1914, construction engineer for Tyson, Weare & Marshall on construction of New Fish Pier; in 1914–15, construction engineer with J. J. Prindiville Co., on new state armory; in 1916, engineer with W. F. Kearns Co.; is now engineer with James E. McLaughlin, architect. Refers to E. W. Colby, Channing Howard, D. P. Kelley, T. R. Lyons and E. B. Richardson.

Ullian, Hyman Benjamin, Dorchester, Mass. (Age 21, b. Lowell, Mass.) Graduate of Mass. Inst. of Technology, 1916, degree of B.S. From June to November, 1912, resident engineer with Massachusetts Highway

Comm.; from December, 1916, to March, 1917, with Fay, Spofford, and Thorndike; is now opening office in land development and subdivision work in Detroit, Mich. Refers to C. R. Berry, R. W. Horne, T. F. McSweeney, H. F. Sawtelle and C. M. Spofford.

LIST OF MEMBERS.

ADDITIONS.

Mattson, William R....................2 Vogel Terrace, Brookline, Mass.
Sheils, Henry C......................1079 Columbus Ave., Boston, Mass.

CHANGES IN ADDRESS.

Atwood, Thomas C. .The Foundation Co., 233 Broadway, New York, N. Y.
Brown, C. Leonard.....................29 South St., Southbridge, Mass.
Chapman, Benjamin R..................The Checkerton, Brockton, Mass.
Eberhard, Walter C..................12 Spellman Terrace, Rutland, Vt.
Elkins, Clayton R...Room 305, Central Union Depot Bldg., Cincinnati, O.
Ferguson, John N.,
Commission on Water Ways and Public Lands, State House, Boston, Mass.
Foote, Francis C......................1200 Jones Bldg., Pittsburgh, Pa.
Fritz, Charles A......................27 School St., Manchester, Mass.
Green, Howard W., Miraflores Water Purification Plant, Corozal, C. Z.
Hyde, Edward R.....................................Manila, P. I.
Jeffers, Robert B.,
Beechwood Park, care of 734 Ridgeway Ave., Rochester, N. Y.
Kimball, Joseph H............Miami Conservancy District, Dayton, Ohio
Knowles, Morris,
1200 B. F. Jones Law Bldg., cor. Fourth Ave. and Ross St., Pittsburgh, Pa.
Newsom, Reeves J....................33 Intervale St., East Lynn, Mass.
Runels, Ralph E....................................Lowell, Mass.
Smith, George A......................Town Engineer, Norwood, Mass.
Sokoll, Jacob M.......................P. O. Box 453, Greenfield, Mass.
Stratton, George E.............U. S. Reclamation Service, Malta, Mont.

DEATH.

Glover, Albert S.,.................................April 23, 1917

RESIGNATIONS.

(In effect March 21, 1917.)

Ackerman, Alexander S.
Allardice, James P.
Bainbridge, Randolph
Collins, Harry B.
Ledder, Gottfred G.
Pinkham, Millard B.
Simmons, John E.

EMPLOYMENT BUREAU.

THE Board of Government maintains an employment bureau for the Society, to be a medium for securing positions for its members and applicants for membership, and also for furnishing employees to members and others desiring men capable of filling responsible positions.

At the Society rooms two lists are kept on file, one of *positions available* and the other of *men available*, giving in each case detailed information in relation thereto.

MEN AVAILABLE.

400. Age 26. Graduate of Dartmouth College, degree of B.S. Has had three years' experience as transitman and assistant engineer on municipal work; experience includes drafting and other office work, paving and sewer construction. Will consider any position along civil engineering lines. Salary desired, $25 per week.

401. Age 24. Educated in public schools and at Technical College, Nova Scotia. Was for two years provincial land surveyor in that province; has also had some experience in general engineering and construction work. Desires position as transitman. Salary desired, $60 per month.

LIBRARY NOTES.

RECENT ADDITIONS TO THE LIBRARY.

On Military Engineering and Related Subjects.

Notes on Military Explosives. Erasmus M. Weaver.

Elements of Military Hygiene. P. M. Ashburn.

Fundamentals of Military Service. Lincoln C. Andrews and Leonard Wood.

Manual of Military Hygiene. Valery Havard.

Military Map Reading. C. O. Sherrill.

Military Preparedness and the Engineer. Ernest F. Robinson.

Military Sketching and Map Reading. Loren C. Grieves.

Mosquito Control in Panama. Joseph A. LePrince and A. J. Orenstein.

Notes on Field Fortification. Army Field Engineer School.

Studies in Minor Tactics. Department of Military Art, Army Service Schools.

U. S. Government Reports.

Report of National Coast Defense Board, 1906.

Production of Lumber, Lath and Shingles in 1915 and Lumber in 1914. J. C. Nellis.

Sewage Disposal on the Farm. George M. Warren.

The Windbreak as a Farm Asset. Carlos G. Bates.

State Reports.

Connecticut. Biennial Report of Highway Commissioner for Term ending September 30, 1916.

Illinois. Addresses and Papers on Insurance. Rufus M. Potts.

New Hampshire. Annual and Statistical Report of Public Service Commission for 1914 15; Reports and Orders of Public Service Commission for two years ending August 31, 1916.

County Reports.

Essex County, Mass. Engineer's Report for 1916.

Municipal Reports.

Auburn, N. Y. Annual Report of Water Board for 1916.

Boston, Mass. Annual Report of Public Works Department for 1915.

Brookline, Mass. Annual Report of Water Board for 1916.

Burlington, Vt. Annual Report of Water Department for 1916.

Concord, Mass. Annual Report of Board of Health for 1916.

Concord, Mass. Annual Report of Road Commissioners for 1916.

Laconia, N. H. Annual Reports of Board of Public Works for 1916.

New Bedford, Mass. Annual Report of Engineering Department for 1916.

New Bedford, Mass. Annual Report of Water Board for 1916.

New York, N. Y. Report to Board of Estimate and Apportionment on Design of Outlet Sewers and Sewer Outlets, 1917.

Northampton, Mass. Annual Report of Water Commissioners for 1916.

Plymouth, Mass. Annual Report of Water Commissioners for 1916.

Springfield, Mass. Annual Report of Water Commissioners for 1916; Office Reference Pamphlet, Municipal Water Works, 1916.

Wellesley, Mass. Annual Reports of Water and Municipal Light Commissioners for 1916.

Miscellaneous.

Bibliography of Colloids. Thorndike Saville. Gift of author.

Canada, Department of Mines: Feldspar in Canada, by Hugh S. de Schmid; Cobalt Alloys with Non-Corrosive Properties, by Herbert T. Kalmus and K. B. Blake.

Report on Destructive Action of Sea Water on Concrete. W. Watters Pagon. Gift of author.

State Sanitation: A Review of the Work of the Massachusetts State Board of Health. George Chandler Whipple. Gift of Harvard University Press.

University of Maine: Tests on Corrugated Metal Culverts.

LIBRARY COMMITTEE.

NEW ENGINEERING WORK.

(Under this head a brief description of new engineering work contemplated or under construction will be presented each month. Engineers and contractors are requested to send descriptions of their work to the Secretary, 715 Tremont Temple, Boston, before 1st of each month.)

Commonwealth of Massachusetts.—METROPOLITAN WATER AND SEWERAGE BOARD. — *Water Works.* — A contract has been awarded to F. A. Mazzur & Company for furnishing and erecting, at the Arlington Pumping Station, a steam turbine-driven centrifugal pumping unit, having a capacity of 3 000 000 gals. in twenty-four hours when pumping against a head of 320 ft.

Surveys have been completed for a 66 000-volt transmission line between the Wachusett and the Sudbury dams, approximately fifteen miles in length.

METROPOLITAN WATER AND SEWERAGE BOARD. — *Sewerage Works.* — Work in progress: Section 98 and Section 102, Wellesley Extension.

Work contemplated: Sections 99, 100 and 101, Wellesley Extension; extension, Deer Island outfall.

METROPOLITAN PARK COMMISSION. — *Charles River Reservation.* — The work of completing the construction of reinforced concrete bridge over the Charles River at North Beacon Street, Boston and Watertown, is in progress.

Work of completing the construction of reinforced concrete bridge over the Charles River at Commonwealth Avenue, Newton and Weston, is in progress.

General. — Work of road repairs in the various divisions is in progress.

BOSTON TRANSIT COMMISSION. — *Dorchester Tunnel.* — The work on Section F, which includes the Broadway Station and the approach for surface cars leading from Foundry Street to the upper level of the station, is in progress.

Work on Section G, which extends from West Fourth Street to Old Colony Avenue, and includes the crossing under the New York, New Haven & Hartford Railroad tracks near West Sixth Street, is in progress.

Work on Section J, which includes the station at Andrew Square, is in progress.

On account of the scarcity of skilled labor, etc., the contractors have not been able to complete their work at the times stipulated in the contracts. After these contracts have been completed, there will remain to be let the contracts for the interior finish of these stations.

The repaving of Summer Street over the portion of the tunnel extending from High Street, through Dewey Square and to Dorchester Avenue, has been awarded to Henry S. Clark, and work will begin at once.

City of Boston. — Public Works Department, Highway Division, Paving Service. — Work is in progress on the following streets:

West Broadway,	from Dorchester Ave. to E St.	Asphalt.
St. Rose St.,	from South St., about 416 ft. northerly.	Bituminous macadam.
Granada Ave.,	from Metropolitan Ave. to Ethel St.	Bituminous macadam.
Cornell St.,	from Orange St. to Colberg Ave.	Bituminous macadam.
Caledonian Ave.,	from Spring St., 200 ft. northerly.	Grading.
Augustus Ave.,	from Metropolitan Ave. to Ethel St.	Bituminous macadam.
Vista St.,	from Augustus Ave. to Malvern St.	Bituminous macadam.
Patten St.,	from Hyde Park Ave. to Bourne St.	Bituminous macadam.
Lorne St.,	from Harvard St., 650 ft. northerly.	Asphalt.
Temple St.,	from Spring St. to Ivory St.	Asphalt.
Epping St.,	from Washington St. to Norfolk St.	Asphalt.
Lithgow St.	from Talbot Ave. to Wainwright St.	Asphalt.
Hill Top St.,	from Granite Ave. to Hallet St.	Bituminous macadam.
Amory St.,	from Centre St. to Bragdon St.	Granite block.
Norfolk Ave.,	from Shirley St. to Burrell St.	Artificial walks.
Albany St.,	from Dover St. to Northampton St.	Granite block.
Canal St.	from Haymarket Sq. to Causeway St.	Granite block.
Lincoln St.,	from Essex St. to Beach St.	Granite block.
McKinley Sq.,	from State St. to Central St.	Granite block.
Asphalt patching,	Miscellaneous streets.	Asphalt.

New York, New Haven and Hartford Railroad. — Construction Department. — Work consists of new 39-stall engine house, 95 ft. turntable, ash pits, boiler house, office building, water tank and necessary trackage.

During past month completed the following: Foundations for office building; placing timber work on turntable rim, and erecting superstructure of sand drying plant.

Progressing on the following:

Engine house: Erection of superstructure and installation of heating and drainage systems.

Office building: Erection of superstructure and installation of plumbing system.

Boiler house: Pouring concrete foundations.

Building ash pits.

Excavating for and pouring concrete foundations for water tank and plugs.

The Fore River Shipbuilding Co., Quincy, Mass., has the following work in progress:

Two oil tank steamers for Texas Co.

Two oil tank steamers for Mexican Petroleum Co.

Five cargo steamers for E. F. Luckenbach.

Two cargo steamers for Cunard S. S. Co.

It is not considered expedient to publish the list of government work on hand at this time.

Vol. IV MAY, 1917 No. 5

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

This Society is not responsible for any statement made or opinion expressed in its publications

ADDRESS AT THE ANNUAL MEETING.

(March 21, 1917.)

By Richard A. Hale, President, Boston Society of Civil Engineers.

In the annual address which the President, according to the by-laws, shall deliver at the close of his administration, it is desirable to consider some of the present conditions and the problems that are to be met in the future. The high ideals of the Society in regard to engineering ethics have been maintained as in the past. The personnel of various state commissions more frequently includes the trained engineer than in the past, and his technical training, in considering problems, renders him of especial value to other members whose training has been along other lines.

A good business judgment is necessary in connection with the technical training, to determine whether, from a financial point of view, many undertakings are desirable. The coöperation of this Society is appreciated by various commissions, who recognize that technical skill and thought is of great assistance in carrying out the lines of work in which they are interested. This coöperation with the state should be the duty of engineers as far as possible; and the Legislative Committee of the Boston Society of Civil Engineers, which has appeared to discuss various bills which were presented to the legislature and in which engineers and municipalities in general were interested, has shown its usefulness in various ways.

The subject of expert testimony should always receive careful consideration. In cases submitted to the Courts for decisions, the testimony of expert engineers on the opposing sides is often conflicting and bewildering to the Court, and shows wide variations in statements presented. This may be due to differences in the points of view which the experts take of the case, each looking at it at a different angle from his brother expert; and there are oftentimes as many angles as experts. It has been suggested by one of our past presidents, in a well-written paper on Expert Testimony, that the German Court method be adopted. This provides that the expert be appointed and remunerated by the Court, in order to remove any tendency to favor the side on which he is retained. It does not seem feasible to adopt this method without modifications. Differences of opinion exist among those who have made careful studies of the cases with which they are connected, and they may be honest in their belief along the lines in which they testify. The chief problem, often perplexing to the Court, is to sift the truth from the various presentations. At the present time there does not appear to be as great a tendency as formerly to bring cases involving expert witnesses and scientific testimony into the courts, but rather to meet in conferences to arrange settlements without resorting to long and expensive trials. The engineer can fill an important part in these conferences of counsel, and aid materially in arriving at logical conclusions. The business judgment of the engineer, in connection with his scientific training, makes a combination that is desirable in such matters.

Cases involving technical matters are now referred more frequently than formerly to engineers as arbitrators, with much saving of time and expense compared to what would be involved in the natural course of court procedure. As an illustration, a case may be cited which occurred some years ago in a neighboring state, involving the interpretation and division of water rights among seven or eight owners. A suit was brought by one of the parties against the others. The case involved many engineering features which were matters of fact. One of the former members of this Society (now deceased) and the writer were retained by opposing parties. As it appeared a great waste of time and expense to work up in duplicate the detail of the case, the writer suggested that, with the consent of counsel, a joint report should be made on agreed facts. This method appealed to all parties to such an extent that the Court appointed a commission, consisting of the two engineers and a lawyer, the latter to advise on legal points. With the writer as chairman, hearings were held and testimony taken regarding facts which it was desired to present by counsel, and a joint report on the technical details was finally made and approved by the Court, and all parties were satisfied. It was a grim satisfaction to the writer as a commissioner to request the counsel to make the examination of witnesses more brief, as the testimony presented was of no great value to the Court.

In a case now in progress before an auditor, the engineers on both sides were authorized to make a joint report on many facts which would have been bewildering to present in any other way, as they were extremely voluminous and would have become hopelessly involved in cross-examination. Under this agreement, many extensive tables of figures, computations, etc., were presented in a clear and logical manner.

An engineer at times meets counselors who are so anxious to win their cases that, rather than seek the truth, they devote themselves to obtaining evidence to suit their views of the case. What they are seeking is manufactured evidence. Fortunately, such lawyers are very rare, and during the writer's experience in expert cases, extending over the last thirty-five years, he has formed many friendly and enjoyable acquaintances among the members of the legal profession.

In the preparation of cases, the engineer should follow a logical, clearly defined plan; should be concise in his statements, and give clear illustrations of what he is attempting to show. Such methods are appreciated by the Court, and more weight is given to testimony of such character than in a poorly prepared case.

I have probably told you what many of you already knew, but it may suggest some thoughts to the younger members of the Society.

At the present time, when Preparedness and Efficiency are the watchwords of the hour, the thought of the engineer naturally turns to those matters in which greater efficiency can be attained, and among those more apparent is conservation of the natural resources, particularly water power. With the high cost of fuel, attention is naturally attracted towards the utilization of water power to the best advantage and greatest economy. When one sees the quantity of flood water wasting in the spring, and considers how much assistance it would render in the summer, in periods of low flow, one feels that conservation of resources should receive greater attention.

This matter, as is well known, has been studied in this state for several years past, and interesting records of the flow of streams are being compiled and studies are being made for reservoirs at the head waters. The subject offers a wide field for investigation by engineers and requires careful consideration. Whether the results attained are commensurate with the expense incurred, and how the expense is to be apportioned, are difficult problems.

In the use of storage reservoirs at the sources of the streams, when developing water powers and acquiring riparian rights, building dams and necessary regulating gates, a large expense may be incurred in proportion to the benefits gained. These problems should be considered so as to give to the water-power users along the stream definite information as to the amount of water which will be delivered from these reservoirs at periods when most necessary to all parties. The distances from the reservoirs to the dam at which the water will be used, and whether the use by parties along the stream is for twenty-four hours or for ten hours per day, are important in determining the value of the power. The value of the water for manufacturing purposes is much greater than for power, which can be replaced. The use of the water for bleaching, dyeing, etc., may be of such importance as to warrant a large outlay in reservoirs.

This is one of the problems that presents itself to the engineer at this time, when efficiency is desirable. The results of the large reservoirs, constructed by the National Government at the head waters of some of our large rivers, to aid navigation, have not been what were hoped, but they have proved of great benefit to water-power users lower down on the stream. In all cases there is difficulty in correctly forecasting wet or dry seasons.

The entire field opens up an opportunity for the engineer to show his skill in these problems. The careful study that is being made on conservation in this state is of great value in connection with the measurements of the flow of streams. Our adjoining states are taking up the subject, and appropriations are being made for studies of conservation and stream flow.

With the heavy freight congestion of the railroads, some method of relief is sought, and the possibility of water transportation on the Connecticut and Merrimack rivers and by proposed canals is being considered; these problems give opportunities for the transportation engineer to investigate the economic conditions and whether the results to be obtained are commensurate with the expense.

In this connection the subject of inland waterways is prominent, and this afternoon we are to have the pleasure of listening to a description of the development of one of the finest systems of inland waterways in the country and its effect on rail transportation.

In our own state an investigation was made about eight years ago by the writer for the Massachusetts State Improvement Commission, regarding the possibility of reviving various waterways that had been projected, and in some cases developed, during past years. The situations, both topographically and regarding conditions of environment, were essentially at variance with those in New York state, and the results of the investigation were not specially favorable. As an illustration: In the study of the old Middlesex Canal, from Lowell to Boston, it was found that although the original bed of the canal was available at portions of its location, other portions had been built upon, and the terminals in Boston were occupied by valuable property. The supply of water required for lockage purposes, to be taken from the Concord River, was a serious matter, as the active season of navigation would occur during the summer months when the flow of the stream was lowest, and the water was of the greatest importance to manufacturers located on the lower portion of the stream. Its greatest value is for general manufacturing uses in dye houses, bleacheries, etc., for condensing, etc., being greater than its value for power, for which substitution could be made. When the Boston & Lowell Railroad was started, it was found that rail competition could not be met, and the Canal Company finally went out of business. The length of the route had some effect on the situation.

Another projected canal was proposed in 1825, by Col. Loammi F. Baldwin, from Boston across the state to the Connecticut River, and thence to the Hudson River by way of a tunnel through Hoosac Mountain. At the time of the state report, in 1909, it was found that the damages to the various water powers located along the proposed route, on account of diversion of water for lockage, would reach an excessive amount. It was also found that many ponds, rivers, etc., from which a water supply for lockage was expected, were being utilized for domestic supplies and were not available for a canal. Various conditions of this kind showed the water route to be unfeasible.

Similar conditions existed along the Blackstone River, where the Worcester and Blackstone Canal was located, and where a railroad was eventually built, and freight went by rail instead of by water. The rates by rail proved more economical, and the water is now used for manufacturing purposes throughout the Blackstone Valley, and is of great value to the mill owners. Other short canals have not been financially successful in competition with railroads in this state, as shown by their general history.

The Cape Cod Ship Canal, completed in recent years, has been successful in providing a shorter route to New York and the South, and has promise of being a financial success. There is no disparagement intended of water routes in comparison with rail routes if a more economical transportation can be assured, but location, distances, centers of distribution, etc., must be considered in individual cases, and whether a system of inland ways for Massachusetts can be successfully developed remains to be solved by the skill and ingenuity of the engineer.

The conditions in the state of New York, with its network of canals and canalized rivers and large western commerce, present most favorable conditions for water transportation, which doubtless will show a saving over rail routes. We should all greet with pleasure any developments in waterways and terminals in this state that will prove economical investments for the community.

The attempted regulation and conservation of water power by the National Government has resulted in a chaotic condition of affairs, as indicated by various bills and amendments before the present Congress, which failed to pass. The experience of private water-power development during the last seventy years has indicated the large investments required in building the works and the years that elapse before adequate returns are made to those whose funds are invested. Companies now prosperous have had their times of depression; one company, as was remarked by one of its officers, paid one dividend on expectation and lost twelve on facts. The history of water-power companies in the middle and southern states shows that financial reorganization and readjustment have been of frequent necessity, and investors have suffered accordingly.

Taxing a water-power franchise, which in its development produces taxable property and develops new industries in a community, produces a heavy burden on the subject, and the result has been the abandonment of water-power developments until well-defined policies of the National Government are settled by national legislation.

The general dam law of June 23, 1910, contains such drastic provisions that it has prohibited water-power development in navigable rivers since its enactment. This act authorizes the imposition of rents and royalties to be paid into the Federal treasury upon all water power developed. Since that time bills have been introduced to amend the claims of the Government regarding their rights and charges for this power. It is claimed, apparently with justice, that the United States has no general sovereignty over or property interest in navigable waters, and Congress no power to legislate concerning them except for the regulation of interstate and foreign commerce. If that is the case, Congress has no power to require proprietors of lands upon navigable rivers and owners of riparian rights to pay to the

Federal Government, royalties and charges for the use of their own property. The various states of the Union have sole sovereignty and control over these rivers, holding them in trust for their citizens. Those parties to whom these rights have been granted by the state own all property rights and interest in the beds and waters of the streams, and are entitled to the enjoyment of them to the exclusion of people of all other states, subject only to certain uses for navigation as regulated by Congress, and subject to state rights already granted. These propositions do not involve the power of taxation, federal or state. The property and business of those parties who construct dams are subject to federal and state taxation without special provision. This does not controvert the power of the United States to fix rents measured by the water power developed on public land which is leased for dam sites and transmission lines as provided in the Myers Bill. The Supreme Court, only two days ago, has sustained injunctions ousting certain hydro-electric power companies from Federal forest reservations and upheld Federal and limited state sovereignty in developing resources in public lands in the western states. Regulations of the Departments of Agriculture and of the Interior directing the removal of this property from the public lands unless Federal permits were secured, were sustained. The power companies had permission from Utah to develop water power on the forest reservations for public purposes, and in court they contended that the State and not the Federal Government had authority to permit use of public lands within their borders, even on Federal government land. The Government contended that large resources would be lost to the Federal Government if this view were sustained, and that it would destroy at a blow an important element in the plan of conservation. The state maintained that denial of such authority would be an unjust discrimination in favor of states not containing government land. (Eighty per cent. of Utah's entire area, and large percentages of other western states, consist of federal domain.)

The statement has been made that the maximum water horse-power available in the United States is about 61 780 000, without the development of available storage, only about one tenth of which is developed and utilized. The power of navigable rivers alone is estimated 27 000 000 horse-power, of which but a small portion is developed. The present arbitrary laws controlling these rivers have limited development since they were enacted to about 140 000 horse-power.

The necessity of abundant power at low cost is imperative at the present time, when efficiency and economy are sought, and some definite policy to enable those developments to be made without delay is urgently needed. It would appear that the present income tax laws cover all that is necessary without further legislation. A dam which will tend to improve navigation, and relieve the Federal Government of a burden, should not be taxed for water power which has been created.

It is gratifying in the national crisis that is so rapidly developing that this Society has offered its services to the National Government through the Committee of Safety of this Commonwealth, and that our Past-President Gow is chairman of the most important sub-committee of defense which includes many other large contractors. Engineers may have many problems to contend with besides those previously mentioned in this address, and certainly no one will fail to coöperate in matters involving the rights of the United States with reference to other powers, and the rights of American citizenship.

The President wishes to express his appreciation of the coöperation of the members and committees during the past year on various matters which have been brought to the attention of the Society, and bespeaks a successful year under the new guidance that has been selected.

Vol. IV MAY, 1917 No. 5

BOSTON SOCIETY OF CIVIL ENGINEERS
FOUNDED 1848

PAPERS AND DISCUSSIONS

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CHINA MILLS DAM AND SLUICEWAY OF SUNCOOK MILLS.

BY ARTHUR T. SAFFORD,* MEMBER BOSTON SOCIETY OF CIVIL ENGINEERS.

WITH the inevitable decay in wooden dams, the difficulty and cost of buying timber of the dimensions and character required for building them, and the value of any saving in leakage which can be readily transferred into power, the days of the picturesque but leaky dams in New England are fast numbered; and they are rapidly being replaced by tight masonry dams which if thoroughly built make the most permanent and valuable asset to any water power.

The writer had an opportunity this year to replace an old timber crib and masonry dam with a heavy concrete gravity structure which forms the subject of this paper. It is submitted, not with any idea of novelty or because it has solved any unusual problems, but simply to show the tendency towards more permanent structures and the increasing value of water power on our New England streams.

The Suncook Mills at Suncook, N. H., derive their water power from the Suncook River, a tributary of the Merrimack from the east, having its origin in large ponds, in the towns of

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NOTE. This paper will not be presented at a meeting of the Society, but discussion is invited, to be received by W. L. Butcher, editor, 14 Beacon Street, Boston, before August 10, for publication in a subsequent issue of the JOURNAL.

* Hydraulic Engineer, 66 Broadway, Lowell, Mass.

Pittsfield, Barnstead and Northwood, and entering the Merrimack about seven miles below Concord, N. H. The China Mill, the lowest of the three mills of the Suncook Mills, can be seen from the main line of the Boston & Maine Railroad, just before reaching Concord; the automobile road to the White Mountains on the east side of the Merrimack goes through the village of Suncook; and the state highway from Concord to Lake Winnepesaukee and Alton Bay follows up the Suncook River until it crosses the divide in the town of Barnstead.

On " Plat of Meremack River from ye. See up to Wenepesoce Pond, also the Corses from Dunstable to Penny-cook. Jn°. Gardner." drawn previous to 1670, the Suncook (spelled " Sunckook ") is shown as the most important tributary of the Merrimack River from the east.

The drainage area of the river at the China Mill at its mouth is 264 square miles; the hills at the upper part are steep but the valleys broad; the water surface of ponds is about 4 020 acres (or 6.3 square miles); the fall about 424 ft., or 12 ft. to the mile, of which 80 ft. is in Suncook at the Webster, Pembroke and China Mills of the Suncook Mills. At these three mills are approximately 3 000 h.p. of water, of which 1 700 is at the China Mill. The name was given to this mill when its product was mostly heavy sheetings, shipped to the Orient. The mills have a good record, and have been manufacturing cotton cloth at this site since the Civil War.

The China Mill is served by a canal about a quarter of a mile long and of ample proportions, the headgates and coarse racks being located just upstream from the old dam. (Fig. 1.) This dam, built about 1868, was of solid masonry construction for about a quarter of its length on each end, the middle portion being of timber A-frame type with a plank deck on the upstream side. The masonry part was chiefly laid with little or no mortar, the stones being pinned together and partial watertightness obtained by a facing of brick laid in mortar on the upstream side. On the canal side, the dam ended in a masonry pier, between which and the abutment were located two wooden sluice gates, about 4 ft. by 8 ft., intended to drain the pond and to aid in cleaning off the racks. Downstream from this abutment ran a retaining wall about 50 ft. long, built in 1915 of heavy granite blocks laid dry. Beyond this was a gap of about 25 ft. and then a very old loose rubble wall extending downstream for about 60 ft. On the other side was an old abutment wall of granite blocks laid in mortar and extending downstream about 30 ft. below the dam.

The old dam, including the pier and sluice gates, was about 146 ft. 6 ins. long, the pier reducing the effective length by about 8 ft. The average height was about 20 ft., and the head obtained at the mill was about 35 ft. The China Mill has ready for emergencies and dry weather an auxiliary steam plant. The pond, extending back to the Pembroke tail water, is small.

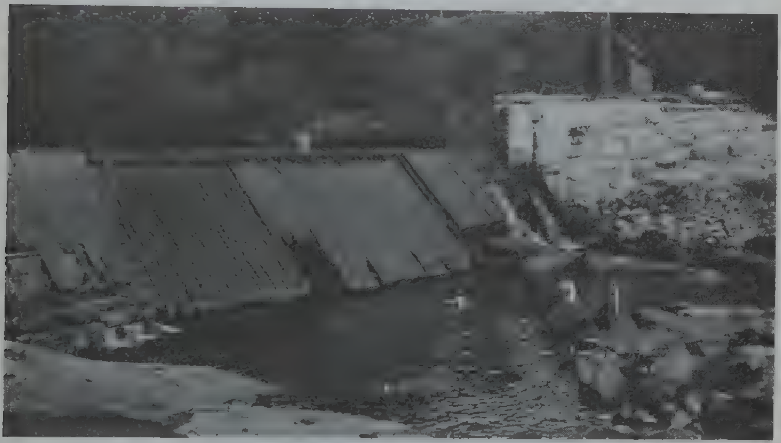


FIG. 1. THE OLD DAM AND LEAK THROUGH IT. "THE OLD SWIMMING HOLE."

Considerable leakage had developed in the old dam, partly in the masonry, but chiefly through the timber portion. This was estimated to amount to perhaps 75 h.p. The timber part was in bad condition (Fig. 2), and, although it had been reinforced with extra bents some years before, it seemed likely that it would fail within two or three years. The possibility was at first considered of patching up the most dangerous places with concrete or other material, but the difficulties in the way of this plan were so great that it was finally decided to build an entirely new dam downstream from the old one. (Fig. 3.) Later, when conditions made a more thorough inspection of the old dam possible, it was discovered that the wisdom of this decision was unquestionable.

With the water at the crest of the old dam, there was a drop of about 18 ins. over some rapids below the Pembroke tailrace of the next dam above; so it was decided to make the new dam that much higher than the old, thus giving a slightly greater pondage, but particularly a valuable increase of head without damaging the Pembroke power.

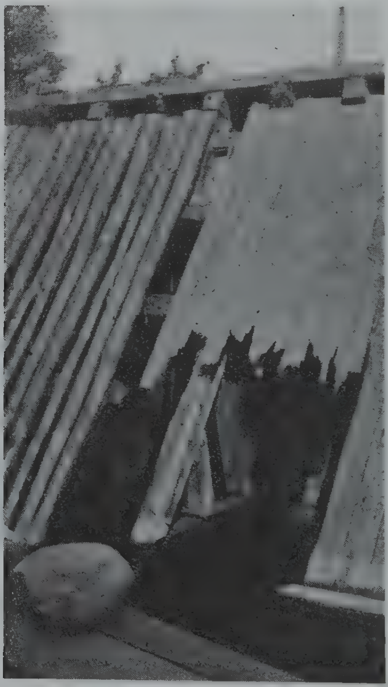


FIG. 2. THE OLD DAM AT CLOSE RANGE.

During construction, the old dam was used as a cofferdam, and in order to make this possible it was necessary to arrange for wasting the surplus water through the China Mill canal.

At the lower end of this canal, and just below the penstock entrance, was a sluiceway into the Merrimack River, but the lower end of this had been washed out completely. The reconstruction of this sluiceway was therefore made preliminary to work on the dam.

SLUICEWAY.

In the first place, the wooden floor of the remaining part of the old sluiceway was taken up and a new concrete floor laid. The walls were of good masonry and left as they stood. The new portion, 184 ft. long and 10 ft. wide, was then built. The floor and walls were of concrete, 12 ins. thick, and the walls, which were 4 ft. high, were reinforced to withstand earth pressure on the outside. For most of its length it was laid directly on the ground, the soil being of tough clay hardpan, but at the lower end it was built on a low stone fill. (Fig. 4.) At the outfall end in the Merrimack River (Fig. 5), piles and sheeting were driven and the wing walls supported on them to prevent undermining. At the upper end, where there was a straight drop of three feet, railroad rails were laid in the floor to save it from wear. (Fig. 6.) This was also done at the upper end, just below the gate.

FIG. 3. SITE OF THE NEW DAM, 60 FT. BELOW THE OLD DAM.

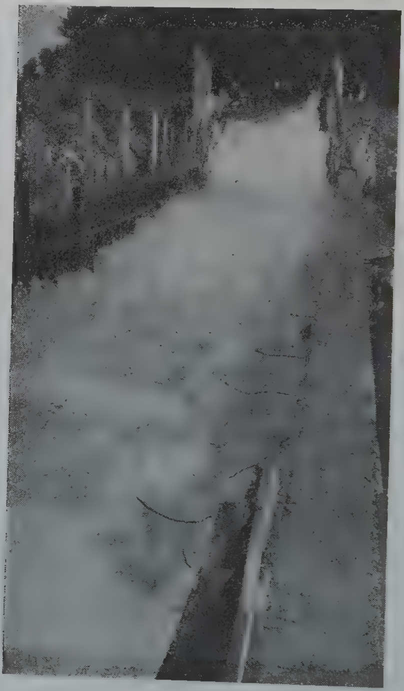


FIG. 4. SLUICEWAY OPEN DURING FLOOD.

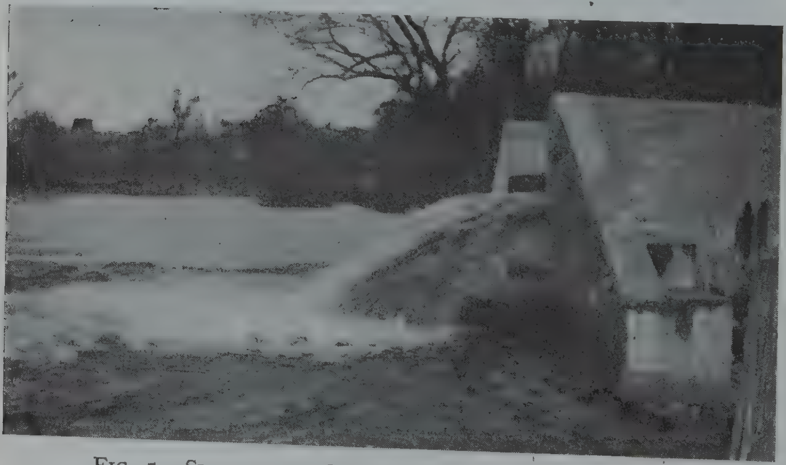


FIG. 5. SLUICEWAY. OUTLET INTO MERRIMACK RIVER.

Owing to the necessity of using the sluiceway before the concrete had hardened, leaks developed in the floor just below the gate; but the source of these was found after some difficulty and the leaks practically stopped.

FIG. 6. SLUICEWAY. GATE CLOSED.

When the water was first let into the sluiceway, a large hole was made in the new wall. This was probably due to some defective cement. The test results on this carload of cement were somewhat uncertain, but it was decided that they did not warrant holding up the work by condemning it. The whole of the carload was used, but no further trouble developed from it. An adjustment was later made for one half this car. The hole thus formed was patched later so that it was watertight, but, owing to cold weather coming on, it was impossible to smooth off the inside face of the wall where the patch was made.

The cost of this job was high, owing partly to the nature of the work, partly to inefficient superintendence, and partly to the employment of more labor than was necessary incident to starting both jobs and in order that a sufficient force might be had when the dam was begun. The quantities and unit costs are as follows:

Grading and excavation	179 cu. yds.	@	$2.13 per cu. yd.
Forms	4 115 sq. ft.	@	23.7c. per sq. ft.
Concrete	232 cu. yds.	@	$9.15 per cu. yd.
Concrete, including forms	232 cu. yds.	@	$13.35 per cu. yd.

Total cost of work = $4 185.18

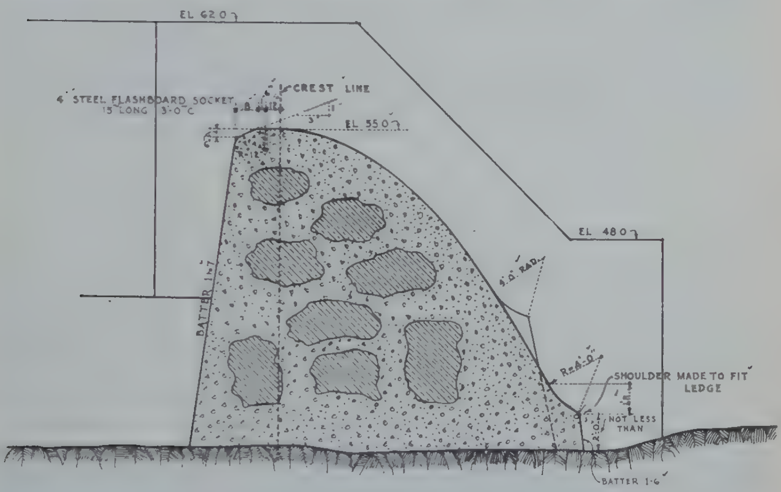
This work was begun about the 8th of August and finished about the 1st of September, when the force was transferred to the site of the new dam.

China Mills Dam.

The location of this dam was chosen at a point where the ledge seemed most favorable, 56 ft. 6 ins. downstream from the crest of the old dam. The new dam was made 147 ft. 2 ins. long, which, owing to there being no pier, gave it an additional length of about 8 ft. 6 ins. over that of the old dam. It was designed for a depth of water on the crest of 6 ft., the maximum observed by the mill officials in the past fifteen years being about 4 ft. Certain marks known to have been reached by the flood of March 2, 1896, made the extra 2 ft. advisable. The design was a heavy section of solid concrete, with a batter on the back of 1 in 7, and a parabolic face. (Fig. 7.) The dam was equipped with flashboard sockets.

The abutment walls on each side were carried up 7 ft. above the crest. They were run upstream to the abutment of the old dam. On the north side where the old abutment wall was laid in mortar the new wall was built directly on top of it, the old wall being thought watertight. It later developed that it was not, so that it was necessary to put a thin facing of concrete over it. Downstream on this side, the new wall was sloped down along the face of the dam, and then turned at right angles and run into the natural soil of the bank. Riprap was laid on the bank as additional protection for about 30 ft. further downstream.

On the south side, where the old wall was of dry masonry, it was faced with about 24 ins. of concrete. Below the dam this wall was sloped down as on the other side, and then run at right angles into the very old dry rubble wall. It was then carried downstream for 25 ft., making a facing for the old wall about 24 ins. thick. Beyond the end of the concrete, riprap was laid up along the foot of the old wall for the remainder of its length.



TYPICAL SECTION OF DAM

SCALE 1"=4'-0"

FIG. 7.

On this side a sluice tunnel 5 ft. square was built which ran through the dam and upstream along the foot of the wall to just below the old sluice gates. At this point a hollow pier was built up to the top of the abutment wall and a gate and hoist installed. The tunnel was made of reinforced concrete. The intention in running it upstream so far was for it to take the place of the old sluice gates when cleaning off the racks, as well as for draining the pond.

Construction was begun at the north end, on the opposite side from the canal, because the concrete plant was located there adjacent to the railroad and highway. The cement used was Lehigh, tests being furnished on each carload. The aggregate was gravel obtained from a bank about a mile away and hauled in carts to the job. The main part of the dam was made of a 1–3–5 mixture, although the sluice tunnel and certain parts of the walls were mixed 1–2–4. The gravel was very clean and did not vary greatly in proportions. A small amount of stone had to be added to the mix, and this was obtained mostly by screening gravel at the bank. Two cars of crushed stone, however, were used for this purpose.

A pool of some depth had been formed below the old dam, and it was found necessary to build a cofferdam across this in order to get at the foundation of the new dam. The foundation was of mica schist, mixed with some softer stone, most of which had been worn away. All loose material was barred or wedged off, but no blasting was done except to break up loose rocks too large to be handled by the derrick. In general, a sound bottom was found with very little excavation; but at several points there were pockets from four to ten feet deep full of loose material. Such pockets were found usually to overlie a stratum of blue clay hardpan a couple of inches thick. It appeared useless to take out the rock everywhere down to this stratum of clay because in all likelihood another would be found some feet lower, and the amount of solid rock above it was enough to insure against any sliding on the clay. In one of these pockets a stream of water forced itself through the clay streak and bubbled up under the site of the dam. This leak was plugged, as far as possible, with bags, and forced back so that it came out near the upstream heel of the dam. Concrete was then poured as fast as possible into the crevice from which the flow came, forcing it back until it came out upstream from the heel.

Another pocket was found at the foot of the old wall on the south side, so deep that to excavate it entirely would have endangered the stability of the wall. It was therefore cleaned out as far as was thought safe, and a seal obtained by carrying the concrete fill for the floor of the sluice tunnel out beyond the pocket to where sound rock lay at a higher elevation.

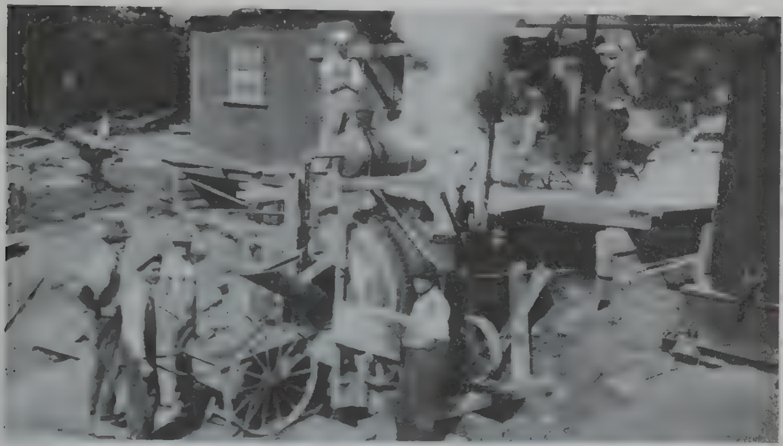


FIG. 8. THE SOURCES OF AMMUNITION AND THE MEN BEHIND.

The dam was built in four sections, beginning at the north end. A trestle was built out from the concrete mixer (Fig. 8), on the upstream side of the dam, and from this the concrete was dumped into the forms (Fig. 9). When convenient, chutes of galvanized iron pipe were used. Large stones, of sizes up to the capacity of the derrick, were placed in the dam as close

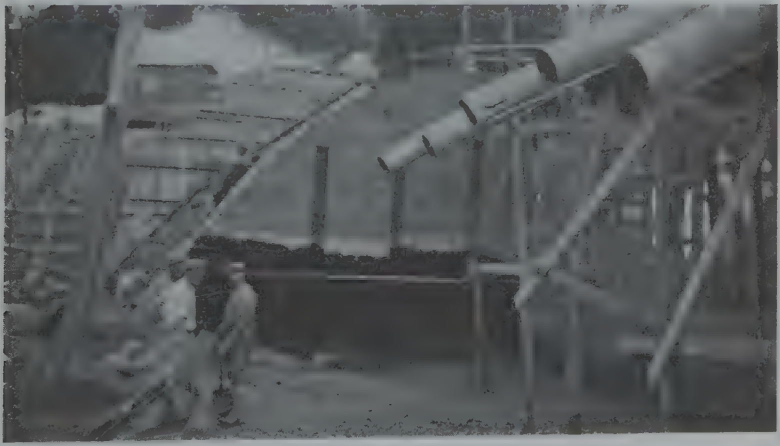


FIG. 9. THE CONCRETE GUNS.

together as a proper bedding would permit. These stones were obtained from the excavation and river bed nearby.

When the first section was nearly finished and the second begun, a heavy rain caused a sudden considerable rise in the river. This carried out a portion of the trestle and the forms for the second section, and washed much of the fill out of the cofferdam (Fig. 10). The work was not delayed to any extent, however, because it was possible to go on and finish the first section of the dam during the flood, and when the river went down, the concrete that had been placed in the second section was found uninjured. It was only necessary to rebuild part of the trestle and the forms that were destroyed. It was not necessary to refill the cofferdam, as its chief use was in building the first sec-

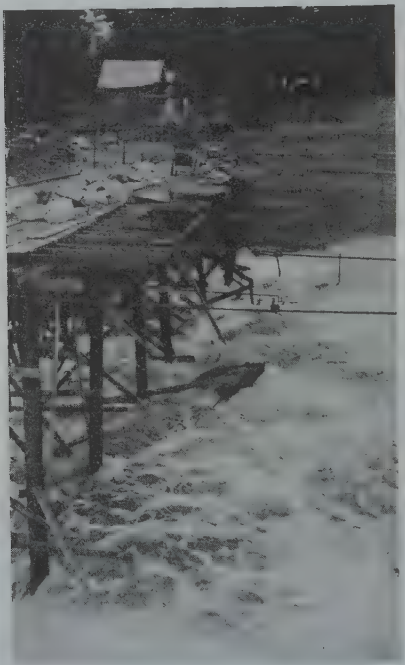


FIG. 10. A LITTLE HARD LUCK.

tion, and it was found that by plugging a few of the leaks with bags the foundation of the remainder could be kept dry.

Having finished the first and second sections and the north abutment wall, the fourth section, along with the sluice tunnel and the south abutment, was next built. This was a short section, just wide enough to include the sluice tunnel. A leak that had formerly come through the old abutment wall was taken through the new work in a pipe, and after the wall was finished the pipe was plugged. The water then followed along behind the new wall and escaped beyond the end of it downstream from the dam. The source of this leak was not found, and, in view of the necessity for doing some more work in the near future towards improving the entrance to the canal, it was not thought worth while to go to the expense of stopping it.

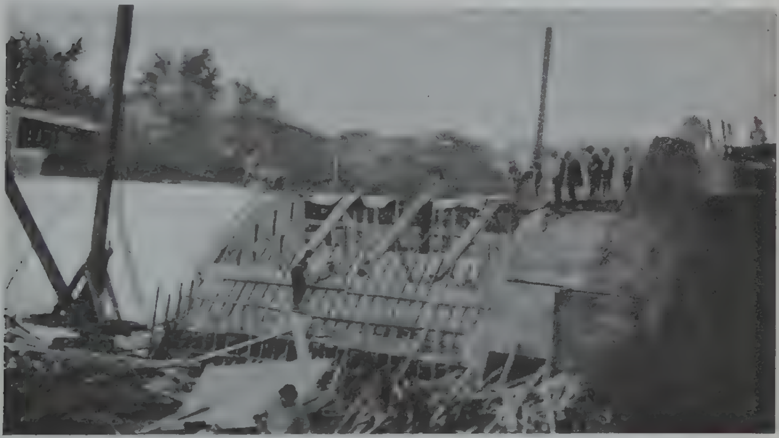


FIG. 11. THE DAM ABOUT FINISHED.

While this section was under construction, the water that came through or over the dam was taken off through the gap where the third section of the dam was to be; but as soon as the fourth section was finished the water was diverted through the sluice tunnel and the foundation cleaned for the third section. The closing section of the work was thus a plain dam section (Fig. 11), uncomplicated by walls or other details, and could be poured with the greatest despatch, thus minimizing the danger of another flood. It was practically finished in two days without encountering any difficulties.

The best day's work was on October 11, 1916, when 184 cu. yds., including large stone, were deposited in thirteen hours (8 A.M. to 11 P.M.) at a total cost of $3.98 per cu. yd., including labor and materials.

In pouring the last lift of the first section, some trouble was given by a platform to facilitate dumping the concrete which was built out from the runway trestle and rested on the form. This caused the form to sag somewhat, but too much allowance was made for this, so that the crest on this section is about an inch and a half higher than it should be. This mistake was eliminated on the rest of the work.

After the last section had been poured, the gaps in the walls where the runway trestle had been located were filled in, and the walls were backfilled with material from the excavation. This backfilling was not carried up to the top of the wall, but left somewhat below, so that the remainder of the fill might be made from time to time by the mills.

The walls were designed for a backfilling of loosely laid rubble, thus making them of a fairly light section. The backfilling where the wall was self-supporting was done with this in view.

The old dam was then torn out to below water level, the masonry being thrown over into the space between the dams, and the timber blasted and pulled out by the derrick. The old sluice gates were taken out and the pier torn down to water level, but the gate frame could not be entirely removed owing to water conditions. This was accordingly left to be done when circumstances permitted.

When the pond was filled by the tearing out of the old dam, the new dam appeared to be quite tight, no indication of any leak being found. A considerable leak, however, developed around the north end, escaping over the wing wall below the dam. It was decided to try and stop this by facing the old masonry wall mentioned earlier in this account, and while this stopped most of the flow, enough remained to make a cut-off wall advisable. Excavation was begun for this, starting at the end of the old wall where it joined the new work and running somewhat diagonally upstream and back into the bank. It was thought that by running the wall in this direction, rock would be found at a higher elevation. The natural soil which had never been excavated was, however, found to be so tight that it was not necessary to go down to ledge except near the wall. When the excavation had got down to the level of the wing wall, water stood in the trench, and, as it was thought that pumping might open the leak wider, the work had to be continued on Sundays, when the pond could be drained out. When ledge was reached and uncovered back to a point where the natural soil began, concrete was poured into the trench up to the level of the top of the dam. From this point up to the top of the abutment wall the wall was made 12 ins. thick. The result was to stop the leak, the very small flow that remained being due probably to ground water. The weather had become quite cold before this wall was finished, but by heating the gravel a good quality of concrete was secured.

Payment on this work was made on the basis of cost plus ten per cent. for the sluiceway and taking out the old dam; on the new dam the same except that the cost was guaranteed not to be more than $18 000 if the quantities did not overrun 2 050 yds. of concrete and 350 yds. of excavation. For any overrun there was to be added to the guarantee $2.00 per yd. for excavation and $8.00 per yd. for concrete.

The quantities and unit costs on the work are as follows:

Dam excavation	646 cu. yds. @ $2.15 per cu. yd.
Dam forms	14 990 sq. ft. @ 17.9c per sq. ft.
Dam concrete	2 385 cu. yds. @ $5.20 per cu. yd.
Dam concrete, including forms,	2 385 cu. yds. @ $6.33 per cu. yd.
Total cost of dam (exclusive of sluice gate and hoist)	$17 436.54
Sluice gate and hoist	$520.55* plus freight on hoist.
Taking out old dam	$182.52
Putting in cut-off wall	$667.17

The total cost of the sluiceway and dam, including preliminary work, engineering and inspection, was $25 300, or $9.67 per cu. yd. of concrete of all kinds in place, excavation, etc., being figured as preliminary work.

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* This does not include commission on gate hoist.

The contractors for the work were the H. P. Cummings Construction Company; the engineer was the writer, and the resident engineer on the job was Walter H. Durfee, of Turners Falls, Mass., Power and Electric Company.

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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WHEN TO DIMENSION IN FEET AND INCHES AND WHEN IN INCHES ALONE.

By Sturgis H. Thorndike.*

Many engineers are facing the difficulty of making a rule which will determine when dimensions should be stated in feet and inches and when in inches only. No standard rule has been adopted by engineers generally, and, so far as I can discover, even individual firms and organizations find difficulty in consistently following the rules they adopt. The attempt is sometimes made to set an upper limit, say two feet, using inches alone below this limit and feet and inches at and above it, but no such arbitrary limit can be kept free from exceptions or appears likely to become a final and generally adopted standard. The problem is constantly before any one drawing plans, and consequently is of considerable interest. It perhaps lends itself more readily to consideration in a series of communications to a journal like ours, rather than to discussion at a meeting. It is with the hope of starting such a series that I offer the following suggestions.

For use in engineering structures, the so-called English system of measures provides two units of length, — the inch

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Note. This paper will not be presented at a regular meeting of the Society, but discussion is invited, to be received by W. L. Butcher, Editor, 14 Beacon Street, before August 10, 1917, for publication in a subsequent issue of the Journal.

* Fay, Spofford & Thorndike, Consulting Engineers, 308 Boylston Street, Boston, Mass.

and the foot. My suggestion is that these be regarded as serving two distinctly different functions. The first unit is adapted to stating the width and thickness of any material or member which is constant in cross-section, but may have any convenient length; that is, *the inch is the convenient unit in which to state size as distinct from length or distance.* For instance, we habitually use the terms 30-in. Bethlehem girder beam, 42-in. steel plate, 16-in. brick wall, 30-in. vitrified clay pipe, 38 in. by 50 in. egg-shaped sewer, 36-in. cast-iron water pipe, 12 in. by 16 in. yellow-pine stick, 28-in. stone coping, 16-in. reinforced concrete slab, etc. We seem naturally to use the inch alone in these cases until the dimension exceeds five or ten feet. On the other hand, we do not speak of a 720-in. roadway. I therefore believe that — perhaps subconsciously — we are using the inch as distinct from the foot and its subdivisions as the convenient unit in which to state the *size* of most materials and members.

The convenient unit for *length* or *distance* seems to be almost always the foot. This unit may be divided decimally, but such division is outside the scope of this present discussion. If it is to be divided into inches, and especially if a number of lengths or distances may sooner or later need to be added together, the greatest convenience seems to be attained when the inch is regarded strictly as a subdivision of the foot, not as a different unit, and consequently when we state a length as 1 ft. 7 in., not as 19 in.

This recognition of the existence of two units, one adapted for one purpose and one for another, may clear up much of the confusion and solve most of the difficulties, including the dimensioning of plans. It sometimes results in stating the same dimension in two different ways on the same plan according to the purpose desired; for instance, the size of an I-beam may be 15 in., but the distance from a plate on the bottom of it to a plate on the top of it will be 1 ft. 3 in. Whether this is an advantage or not is open to question; to me it seems an advantage as emphasizing the difference in use between the two units.

There will still remain a wide field for the exercise of discretion. The limit of size to be stated in inches seems to be a matter of judgment and convenience rather than rule. We speak of a 120-in. wheel base on an automobile, but of a 10-ft. sewer. There will also be differences of opinion on the distinction between size and distance; one engineer will mark his concrete column 28 in. by 32 in. for convenience in figuring stresses; another will mark it 2 ft. 4 in. by 2 ft. 8 in., classing it as a mass of concrete.

I cannot close without calling attention to the fact that this desirability of distinguishing between size and distance, which in our English system induces us to use two different units, hardly exists in the metric system, where, although the units are conveniently distinct, they are so easily convertible that the use of two or more units introduces no confusion or inconvenience.

I trust that this communication may receive attention from other engineers faced with these difficulties, and may draw fire from them to the advantage of all of us.

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BOSTON SOCIETY OF CIVIL ENGINEERS
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PAPERS AND DISCUSSIONS

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NEEDS OF THE ENGINEERS IN WAR.*

THE foregoing chapters have presented a very incomplete outline of some of the engineering duties and a few of the military duties which will devolve upon the engineer company officer in time of war. These subjects are large and have barely been touched upon in this discussion, and there are others which have not even been mentioned. Nothing has been said upon the subject of infantry tactics, which will probably occupy as much of an officer's time as the technical work. Similarly, no mention has been made of the services of security and information, with their subdivisions of outposts, advance and rear guards, patrolling and minor tactics. Camp sanitation, though often introducing problems in disposal of waste and protection of food and water supply which would tax the ingenuity of the average municipal sanitary engineer, has been omitted, and also the subject of military law and government. Coming down to the field of engineering itself, there will be found no mention of roads and railways, though not every engineer knows how to lay a corduroy road correctly, or that the gage of a military railway is made 4 ft. 9 ins., to allow for irregularities of track laying. All these things are beyond the scope of a work of this character, the main purpose of which is to point out the way for the engineer, not to instruct him. It is hoped, therefore, that the material presented will give an idea of the magnitude of the problems which will confront engineers in war, and point out the necessity of individual preparation.

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* From "Military Preparedness and the Engineer," by Ernest F. Robinson. Copyright, 1916, by Clark Book Co. Reprinted by permission of Clark Book Co.

Need of Officers and Non-Commissioned Officers. The army which would be required by the United States as a defense against invasion is placed, by the most conservative estimates, at one million men. In the Civil War we called two million and a half men to the colors, and that was before the days of large armies. With an army of one million we should need 60 000 engineers, of whom 2 000 would be officers and 11 500 non-commissioned officers. The latter are as important to the army as the officers, and particularly so in the engineers. No man should hold a corporal's warrant who is not fully capable of performing the duties of a foreman of construction on civil works, and the grade of sergeant requires a man competent to fill the position of overseer or superintendent on a construction job. Every engineer must not think that his training would in itself entitle him to a commission. Many who entertain this view might find it difficult to hold down a sergeant's job. It is, however, within the reach of every engineer to qualify himself for a commission, and those who do not are contributing to the shortage of officers which will occur upon the outbreak of war, as well as depriving themselves of a military position on a par with their education and social connections.

First-class privates of engineers are skilled workmen: carpenters, blacksmiths, machinists, riggers, electricians, and mechanics of all kinds. Technical men can even find a place in the ranks as sketchers, etc. Second-class privates are of the class of outdoor workmen met at civil works. Lumbermen, miners, boatmen, teamsters, chauffeurs and laborers are fair examples of men useful in the engineers. The lines between the two grades of privates are not closely drawn, length of service, special experience or adaptability often advancing a man from one to the other.

It is probable that many engineers must serve in the ranks as privates and non-commissioned officers, and there is no disgrace in such service. The best citizens of Europe are doing this now, and there is no reason why Americans should be exempt when the time comes. Professor Rawson, in his " Naval

Battles of the World," says of the officers and men aboard the warships, "All in the service are equally servants of the state, and each position is an honorable one, the grades of honor ascending with the degree of responsibility required." A company commander respects and relies upon an efficient and dependable non-commissioned officer as much or more than upon his subaltern officers. Many of the sergeants of the United States Engineers have a reputation throughout the army for their engineering skill, and their practical knowledge of the details of the engineer soldier's work is probably in excess of that of many officers. It means something to be a sergeant in the engineers.

But all cannot be privates, corporals or sergeants. There must be about 2 000 officers, and the engineers of the country must furnish them. There are about 248 in the Corps of Engineers of the Regular Army, and less than 100 in the National Guard, probably less than 300 in all who could be relied upon for active field duty. The field officers can be supplied from the regular army, but about 480 captains, 960 first lieutenants and 360 second lieutenants must be found somewhere, and from where do they come? From civil life direct? Does any engineer reader who has had no military training believe that he can successfully lead engineer troops in the field? Men are quick to detect uncertainty or hesitation in an officer, as a horse recognizes lack of confidence on the part of his rider, and to lose faith in their leader is the first step toward the complete disorganization of troops.

General Morrison, author of "Minor Tactics" and "Infantry Training," says:

"The responsibility resting upon an officer in time of war is great. His mistakes are paid for in blood. To seek a command in war beyond his capabilities is no less criminal than for a man with no knowledge of a locomotive or railroading to attempt running the engine of a crowded express train on a busy line."

National Guardsmen as Officers of Volunteers. Since engineers have taken up seriously the question of military preparedness, the writer has been approached by a number of technical men seeking information regarding service in the engineers of the National Guard. Some of these desire to enter as officers, which is, of course, not possible except to those who have had definite experience in military engineering. Most of them ask, " How long will it take to become an officer?" To this, no definite answer can be given, as the time required depends upon several factors, — the man's ability, the existing vacancies and the competition developed. In the writer's company, during one year, three technical men, with no previous military experience, were commissioned second lieutenants after one year's service. This required extensive preparation on their part, and more time was spent in study than at regular drills; but any engineer who is ambitious enough to work, and has confidence in his ability to win out in competition with other men, may do the same.

It is realized, however, that, with a large technical personnel in the Engineers, well-qualified men might fail to obtain commissions through lack of vacancies, and thus become somewhat discouraged after a length of service which, in their opinion, should entitle them to advancement. The answer is simple. If you cannot hold commissioned rank in the National Guard, you can insure that in event of war *you will immediately receive the rank for which you are qualified.* Under the provisions of an Act of Congress of January 21, 1903, any person in the army or the National Guard, or with previous experience in either, may apply to the Division of Militia Affairs of the General Staff for an examination in any grade for which he thinks himself qualified. Upon passing, he receives a certificate entitling him to a commission in any volunteer force, outside the organized militia, which may hereafter be raised.

The National Guard can thus perform a great service in fitting men for commissions in the volunteers. A number of militia organizations — as, for instance, the 7th New York Infantry — have always furnished large numbers of officers of volunteers in past wars, and there is no reason why the engineers should not do the same for their own branch of the service. This will require additional work for the officers, in holding schools for the men and instructing them in subjects in advance of their duties in the ranks, and will necessitate extra attendances for the men, but such work would be entirely voluntary, and the man can decide for himself whether he wishes to spend the time to acquire an officer's training.

The dream of some National Guard officers is an organization at war strength, ready to take the field intact, and, were the organized militia sufficient in numbers for all demands that might be made, such a situation would indeed be ideal. But, under the present system, we must be reconciled to losing our best-trained men to the volunteers, where they will become officers and non-commissioned officers. It would be manifestly unfair, both to these men and to the volunteer organizations, to retain them in the militia for the sole benefit of the latter. Probably the best-trained infantry troops that could be put into the field would be the battalion of cadets at West Point, but their use as such would be very poor management, to let many organizations suffer from a lack of competent officers, in order that one small part of the army might be highly efficient.

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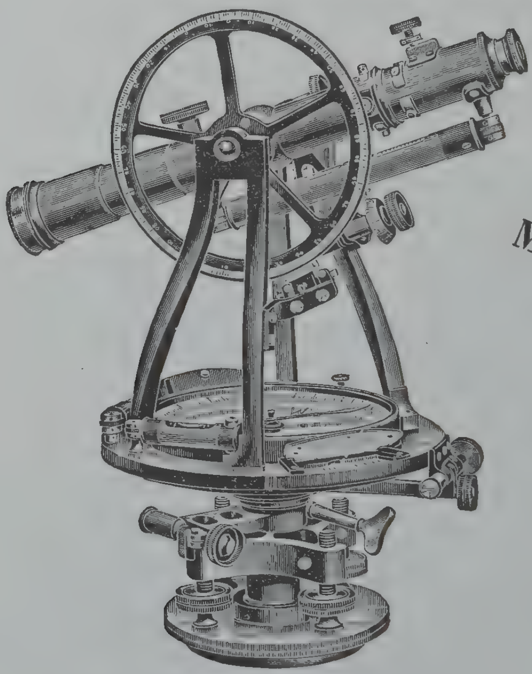

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